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(54) **RAISED ACCESS FLOOR PANEL WITH EMBEDDED SENSORS**

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(51) **Int. Cl.**
H02G 3/38 (2006.01)
E04F 15/024 (2006.01)

(52) **U.S. Cl.**
CPC ***H02G 3/285*** (2013.01); ***E04F 15/02417*** (2013.01); ***E04F 15/02452*** (2013.01); ***E04F 15/02464*** (2013.01); ***E04F 15/02494*** (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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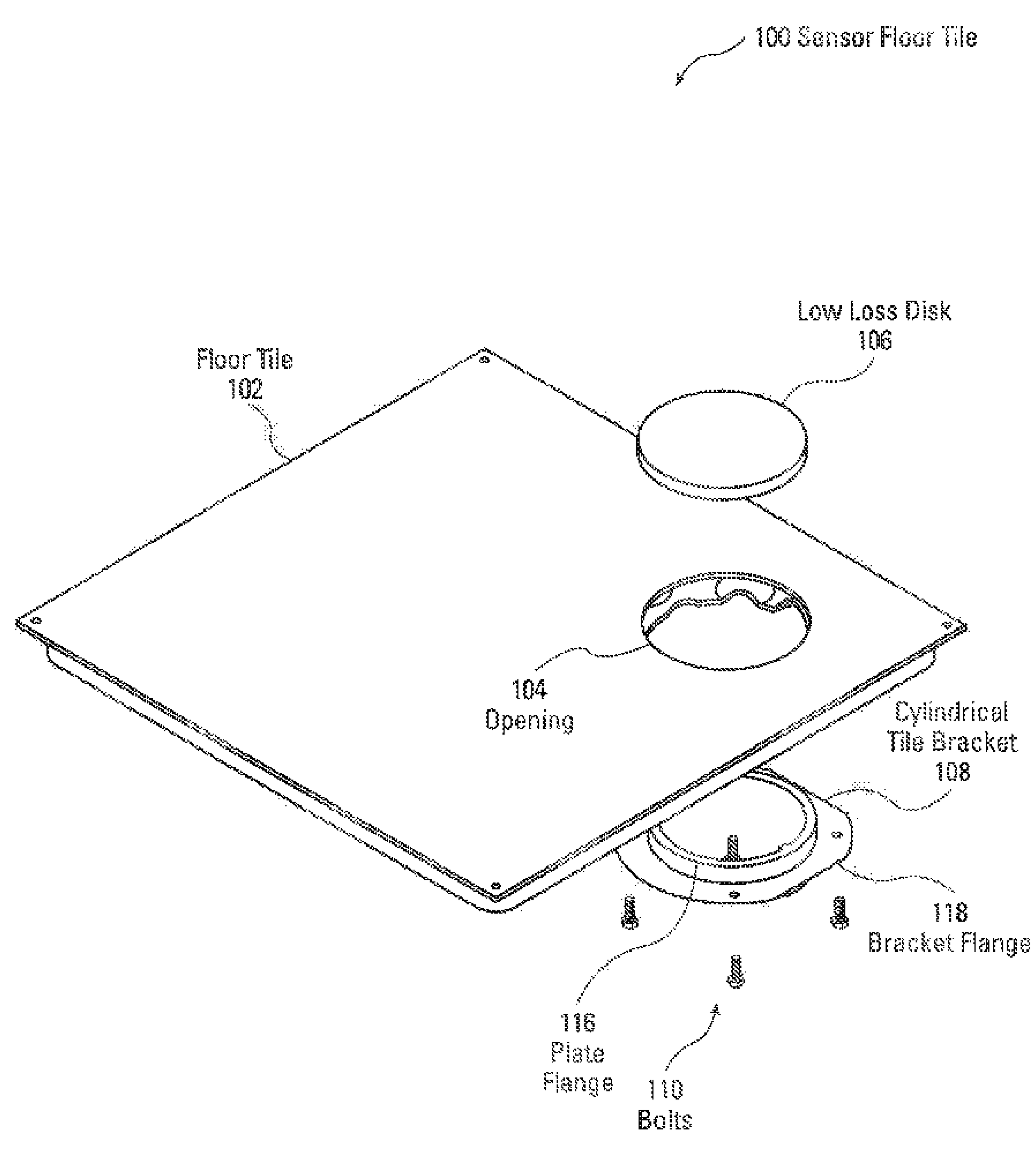
(57) **ABSTRACT**

Disclosed is a sensor floor tile that utilizes a RF frequency transmissive disk that transmits sensor data from sensors located in a plenum of a raised floor system. An antenna is located adjacent to the disk so that sensor signals can be transmitted from the sensor located in the plenum under the floor tile to a wireless receiver located in an elevated location in a data center room, a computer room, a clean room, an office space, etc. A network connection can also be provided by the antenna when the antenna is connected to a router in the plenum.

8 Claims, 9 Drawing Sheets



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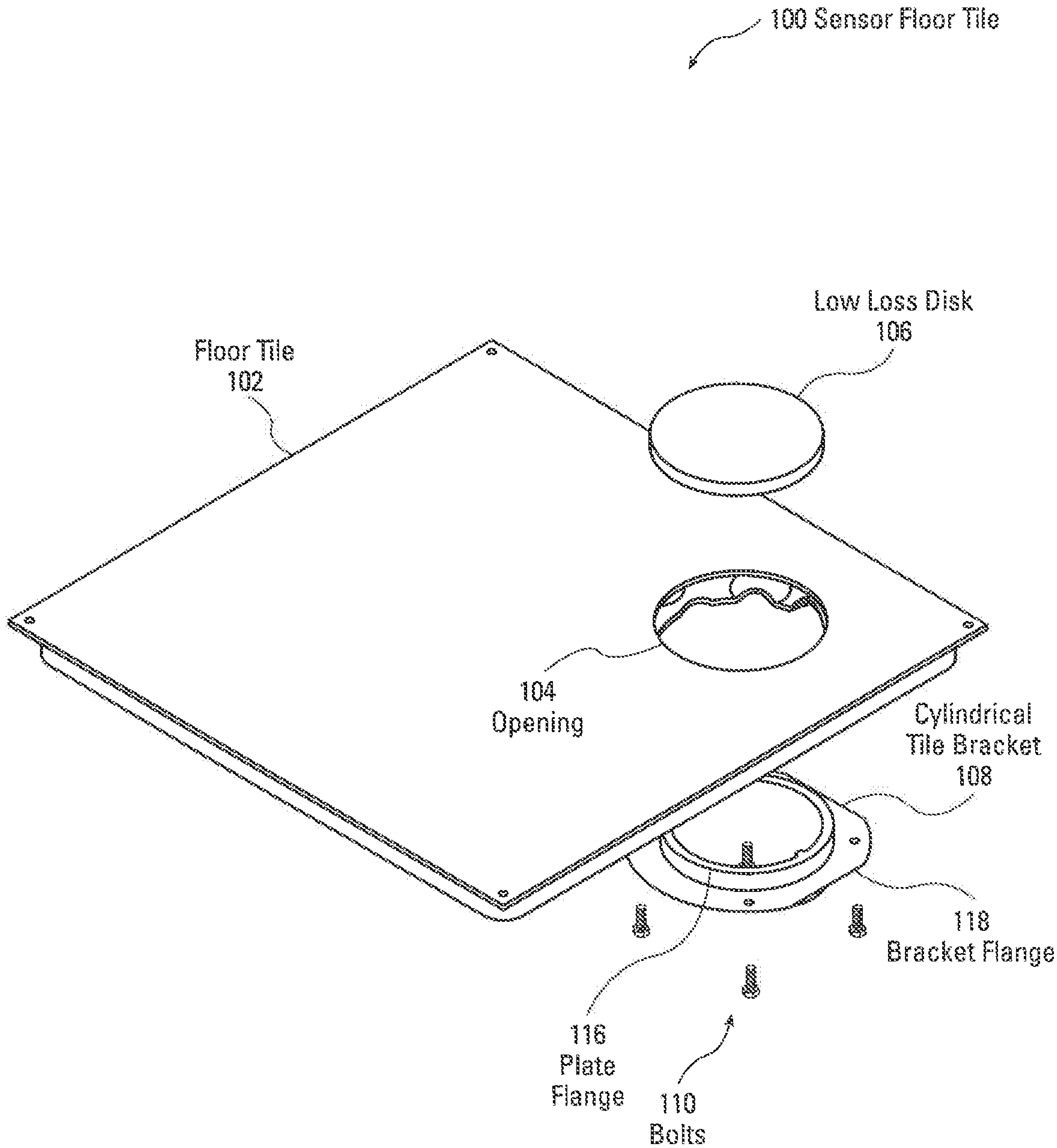

100 Sensor Floor Tile
Low Loss Disk
106
Floor Tile
102
104
Opening
Cylindrical
Tile Bracket
108
118
Bracket Flange
116
Plate
Flange
110
Bolts

Fig. 1

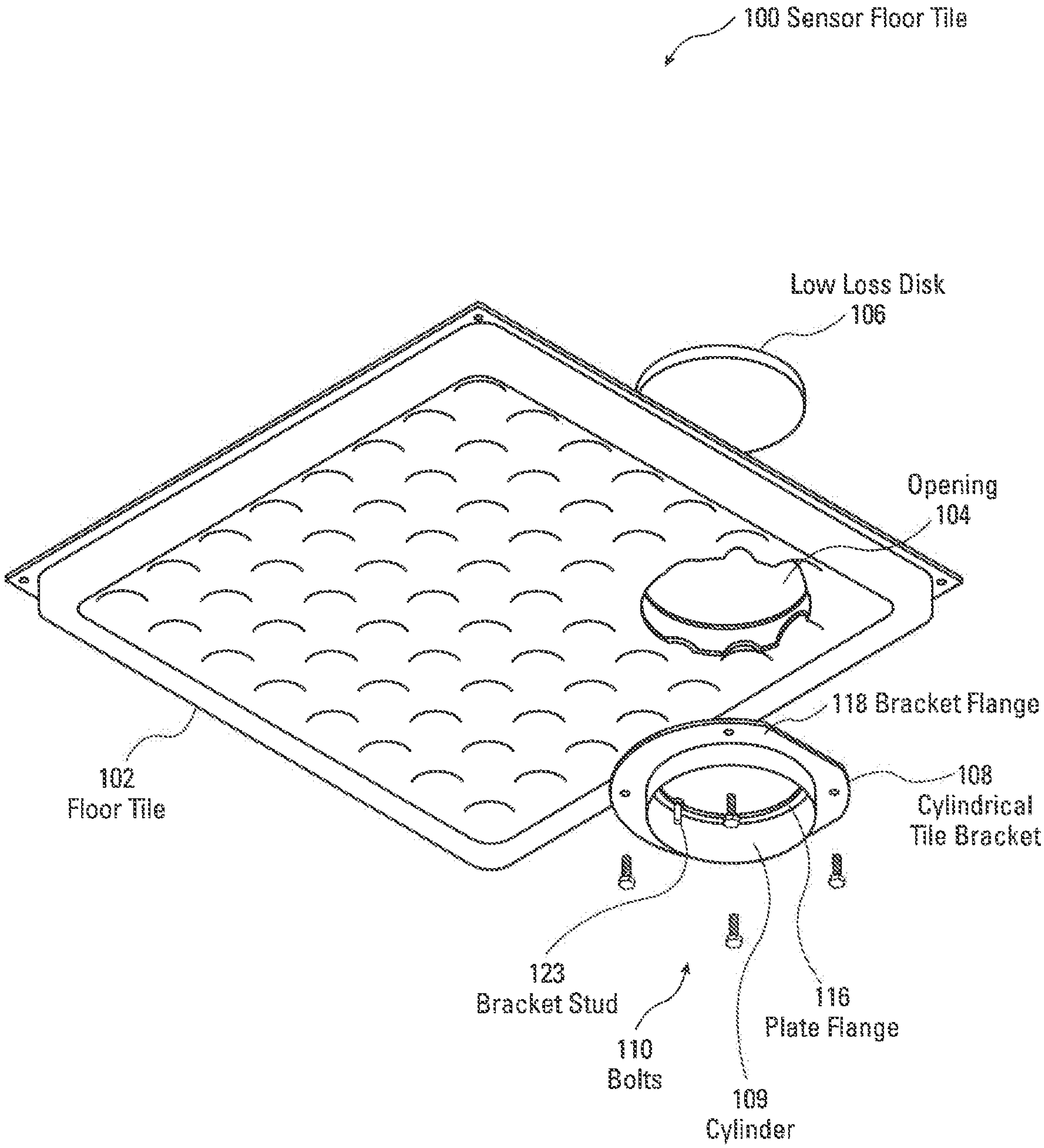

100 Sensor Floor Tile
Low Loss Disk
106
Opening
104
118 Bracket Flange
102
Floor Tile
108
Cylindrical
Tile Bracket
123
Bracket Stud
116
Plate Flange
110
Bolts
109
Cylinder

Fig. 2

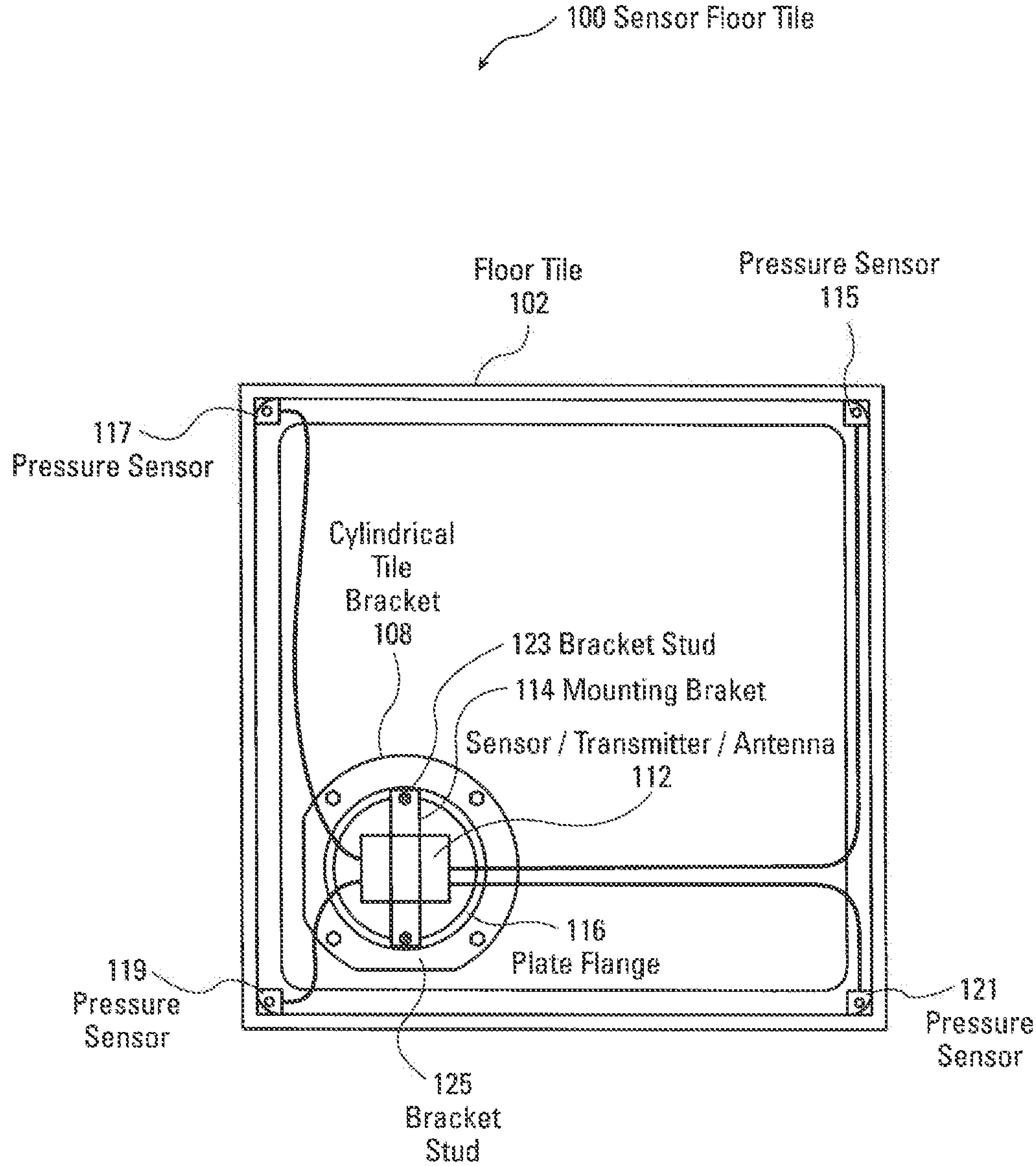
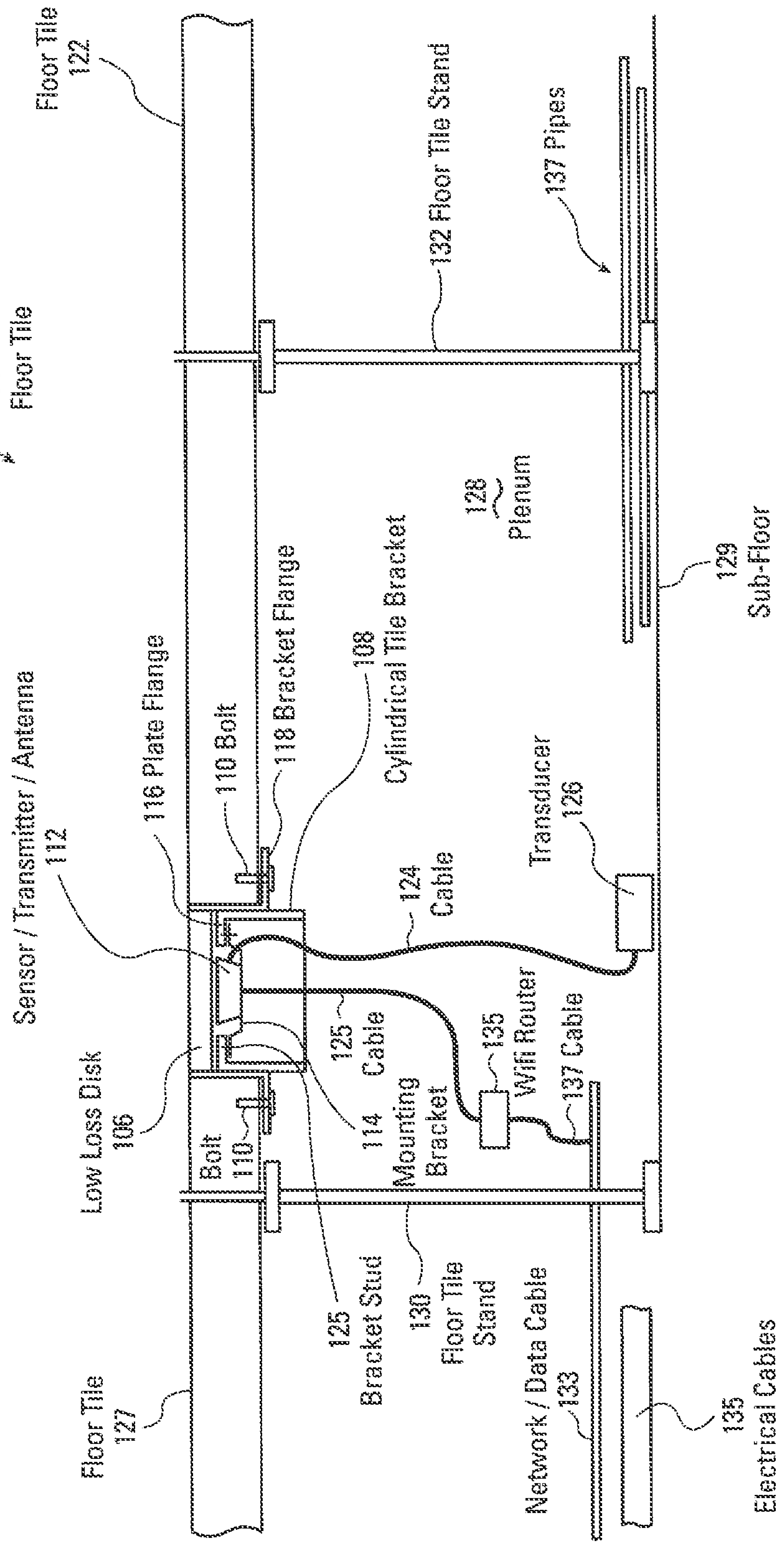

100 Sensor Floor Tile
Floor Tile
102
Pressure Sensor
115
117
Pressure Sensor
Cylindrical
Tile
Bracket
108
123 Bracket Stud
114 Mounting Braket
Sensor / Transmitter / Antenna
112
116
Plate Flange
119
Pressure
Sensor
121
Pressure
Sensor
125
Bracket
Stud

Fig. 3



Floor Tile 122
102 Sensor Floor Tile
132 Floor Tile Stand
137 Pipes
128 Plenum
129 Sub-Floor
Sensor / Transmitter / Antenna 112
116 Plate Flange
110 Bolt
118 Bracket Flange
108 Cylindrical Tile Bracket
Transducer 126
124 Cable
Low Loss Disk 106
Bolt 110
114 Mounting Bracket
125 Cable
135 Wifi Router
137 Cable
125 Bracket Stud
130 Floor Tile Stand
Floor Tile 127
Network / Data Cable 133
135 Electrical Cables

Fig. 4

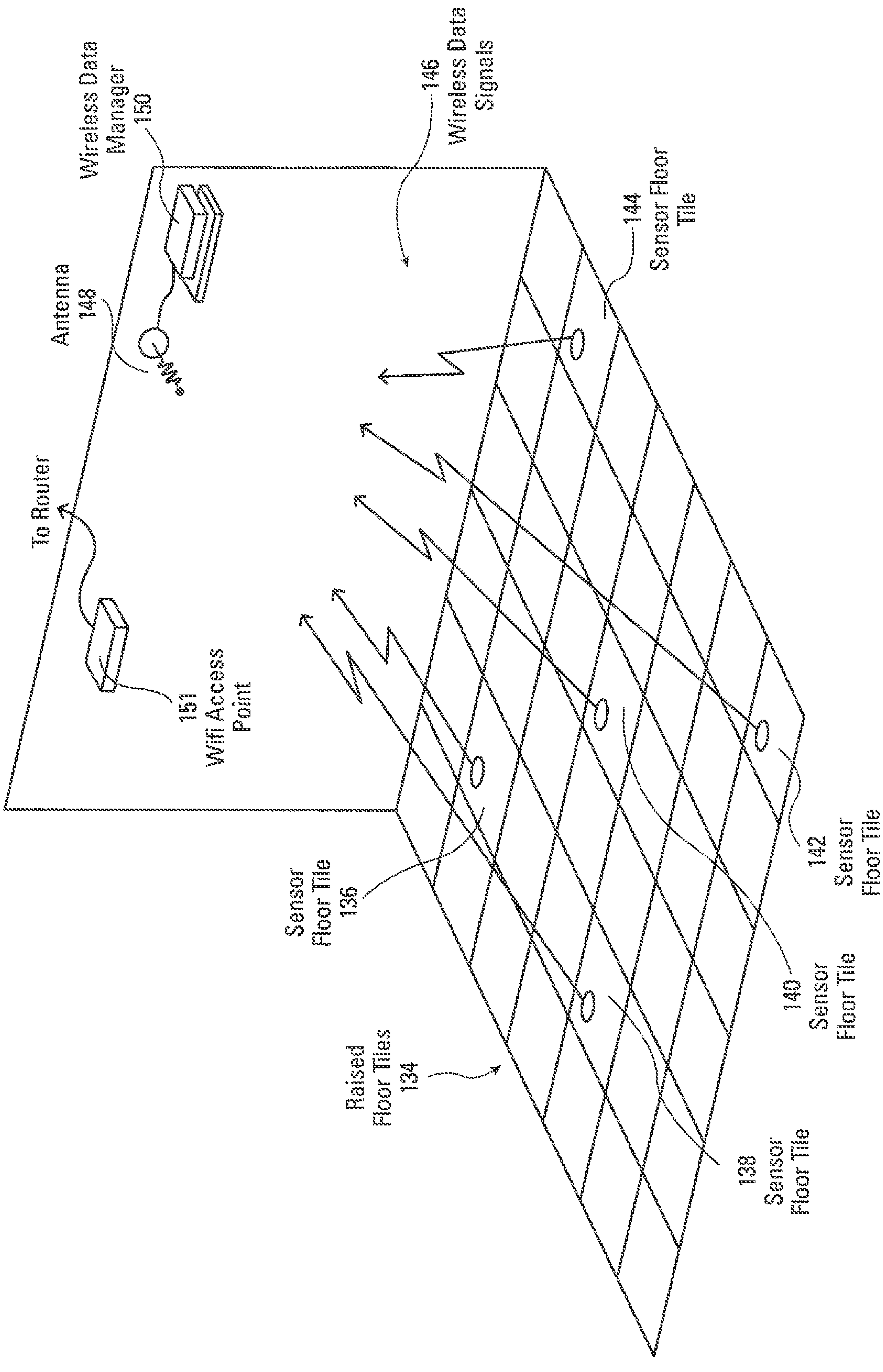
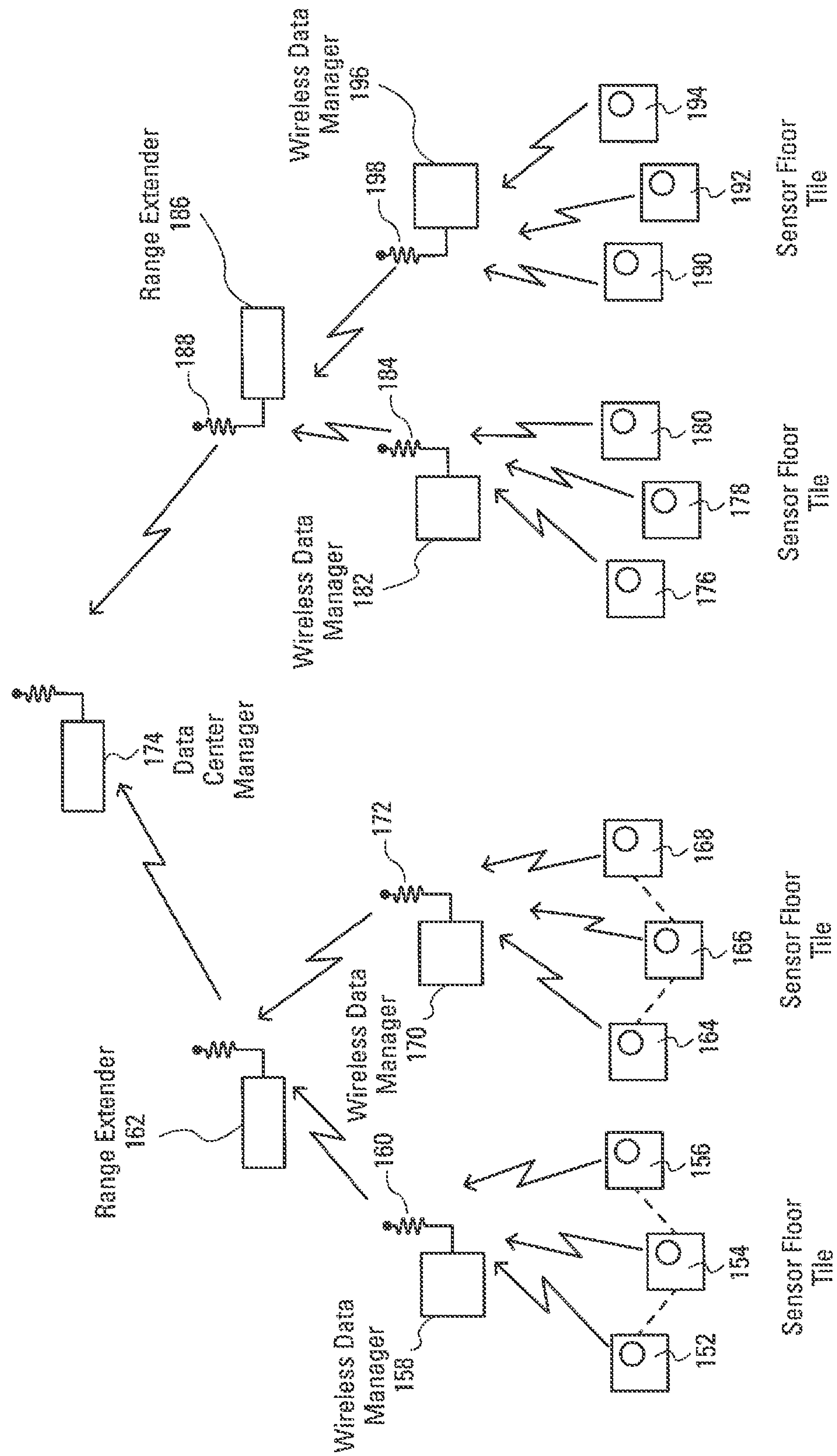

Wireless Data Manager 150
Antenna 148
To Router
151 Wifi Access Point
146 Wireless Data Signals
144 Sensor Floor Tile
Sensor Floor Tile 136
142 Sensor Floor Tile
140 Sensor Floor Tile
Raised Floor Tiles 134
138 Sensor Floor Tile

Fig. 5



Wireless Data Manager 196
198
Range Extender 186
188
184
Wireless Data Manager 182
194
192
190
Sensor Floor Tile
180
178
176
Sensor Floor Tile
174 Data Center Manager
172
Wireless Data Manager 170
168
166
164
Sensor Floor Tile
Range Extender 162
160
Wireless Data Manager 158
156
154
152
Sensor Floor Tile

Fig. 6

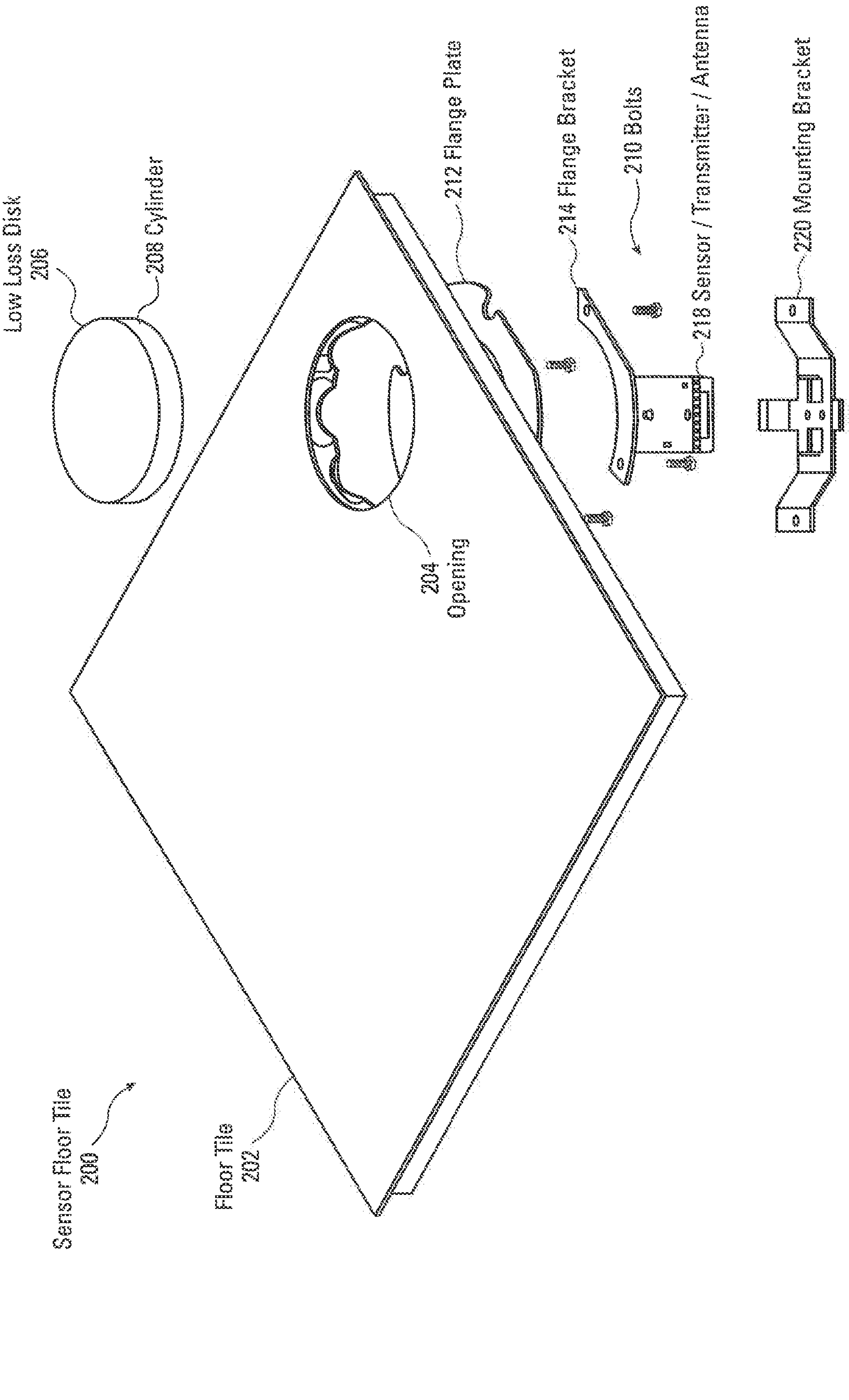

Low Loss Disk
206
208 Cylinder
212 Flange Plate
214 Flange Bracket
210 Bolts
218 Sensor / Transmitter / Antenna
220 Mounting Bracket
204
Opening
Sensor Floor Tile
200
Floor Tile
202

Fig. 7

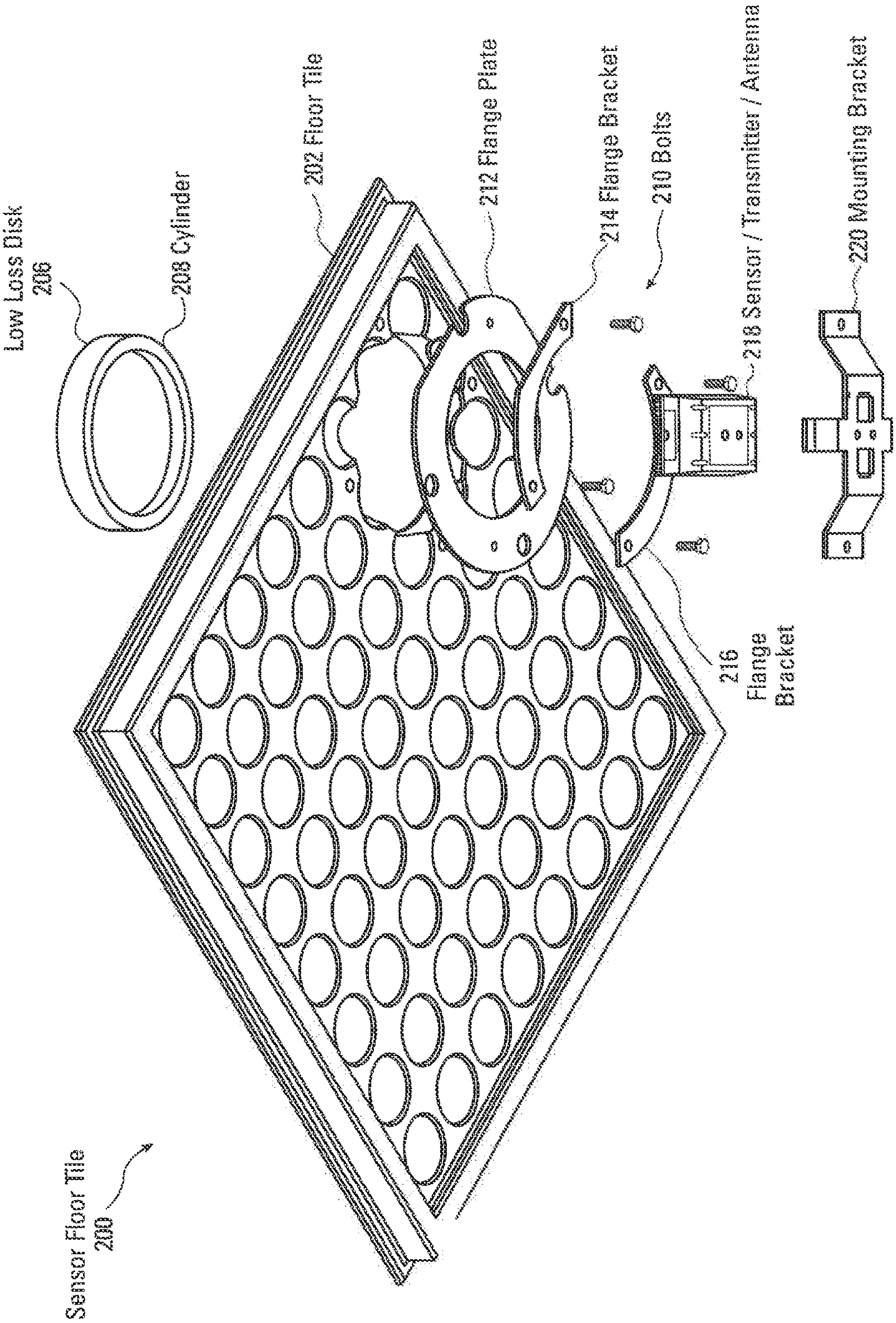
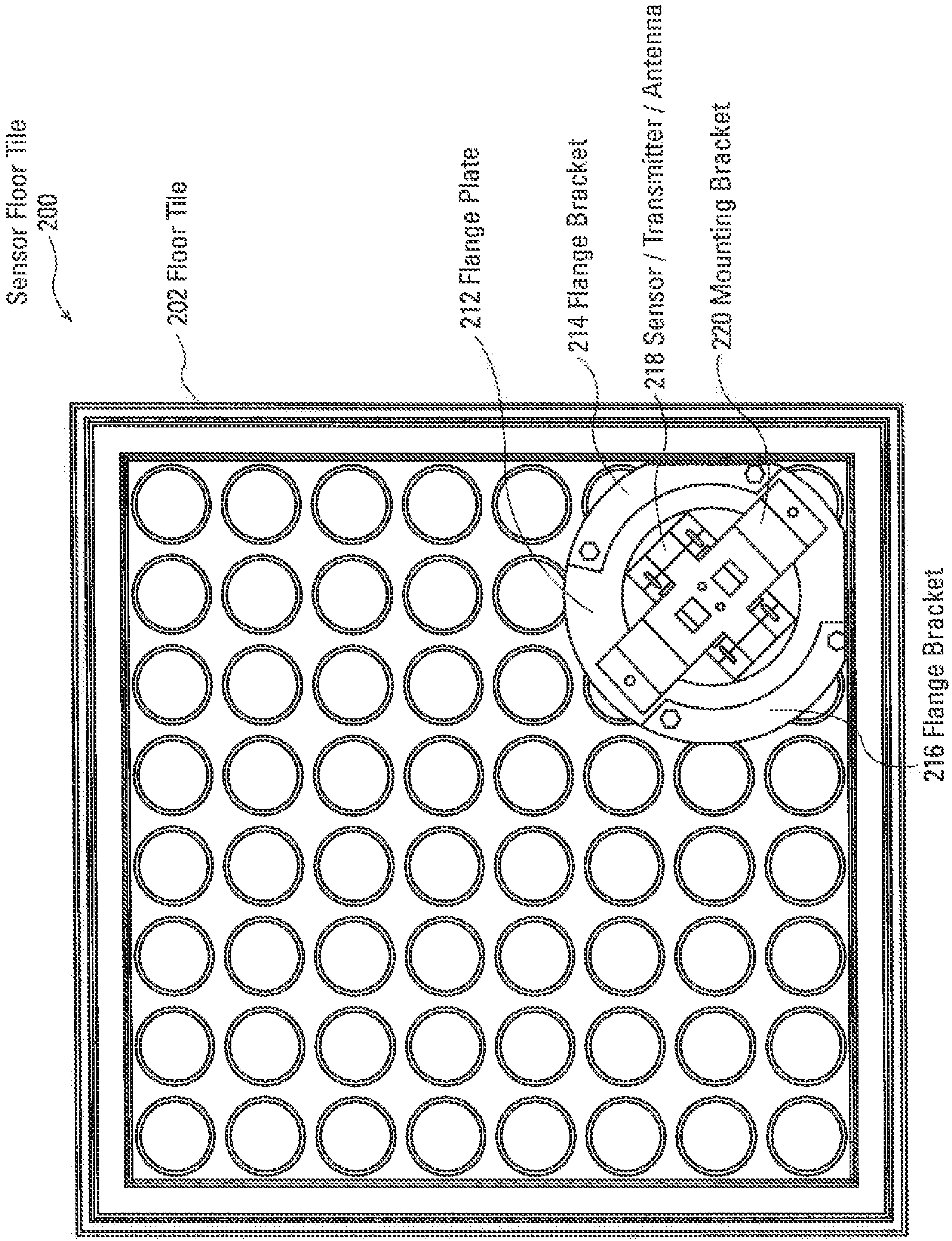

Low Loss Disk
206
208 Cylinder
202 Floor Tile
212 Flange Plate
214 Flange Bracket
210 Bolts
218 Sensor / Transmitter / Antenna
220 Mounting Bracket
216
Flange
Bracket
Sensor Floor Tile
200

Fig. 8



Sensor Floor Tile
200
202 Floor Tile
212 Flange Plate
214 Flange Bracket
218 Sensor / Transmitter / Antenna
220 Mounting Bracket
216 Flange Bracket

Fig. 9

RAISED ACCESS FLOOR PANEL WITH EMBEDDED SENSORS

BACKGROUND

Floor tiles are used in raised flooring systems, that are prevalent in data centers, clean rooms and various computer rooms that contain servers and complex, high-speed computers. Raised flooring systems are also used in office buildings, apartments and high rise buildings used for various purposes. One of the advantages of using a raised flooring system is that all of the utilities can be run in the plenum under the floor tiles, which makes the utilities easily accessible. In addition, air conditioning and heating can be run through the plenum under the tile, which removes the necessity of running separate duct work. Furthermore, carpet tiles and wood coverings can be placed over the floor tiles to provide a pleasing appearance for offices and apartments. Because of the ease of access to the utilities in the plenum under the floor tiles and other advantages provided by a raised floor system, raised floor systems using floor tiles have found widespread use and such use is increasing.

SUMMARY

The present invention may therefore comprise a sensor floor tile comprising: a metal floor tile having an opening that extends from a top surface to a bottom surface of the floor tile; a tile bracket having a plate flange that is disposed a predetermined distance below the top surface of the floor tile; a insert having a thickness that corresponds to the predetermined distance so that the insert is flush with the top surface of the floor tile when the insert is disposed in the opening and placed against the plate flange, the insert made from a material having high transmissivity of radio frequency signals; a mounting bracket connected to the tile bracket; a sensor/transmitter/antenna disposed in the mounting bracket so that the sensor/transmitter/antenna is adjacent to the insert when the insert is disposed in the opening; sensor signals that are transmitted by the sensor/transmitter/antenna as radio frequency waves through the insert.

An embodiment of the present invention may further comprise a method of transmitting sensor data in a raised floor system comprising: providing a floor tile with a top surface and a bottom surface and an opening that extends through the thickness of the floor tile between said top surface and the bottom surface; mounting a tile bracket to the floor tile that extends into the opening so that a plate flange on the tile bracket is located in the opening at a predetermined distance from the top surface; placing a insert in the opening that rests on the plate flange of the tile bracket, the insert having a thickness that corresponds to the predetermined distance so that a top surface of the insert is flush with the top surface of the floor tile when the insert is disposed in the opening; securing a sensor/transmitter/antenna in the tile bracket so that the sensor/transmitter/antenna is disposed directly under the insert when the insert is disposed in the opening; transmitting sensor signals by radio frequency waves through the insert.

An embodiment of the present invention may further comprise a floor tile comprising: a metal floor tile having an opening that extends from a top surface to a bottom surface of the floor tile; a tile bracket having a plate flange that is disposed a predetermined distance below the top surface of the floor tile; an insert having a thickness that corresponds to the predetermined distance so that the insert is flush with the top surface of the floor tile when the insert is disposed in the opening and placed against the plate flange; a mounting bracket connected to the tile bracket; an antenna disposed in the mounting bracket so that the antenna is adjacent to the insert when the insert is disposed in the opening; a router connected to the antenna that generates and receives network signals that are transmitted and received by the antenna as radio frequency waves through the insert; a network cable connected to the route that generates and receives the network signals.

An embodiment of the present invention may further comprise a method of transmitting sensor data in a raised floor system comprising: providing a floor tile with a top surface and a bottom surface and an opening that extends through the thickness of the floor tile between the top surface and the bottom surface; mounting a tile bracket to the floor tile that extends into the opening so that a plate flange on the tile bracket is located in the opening at a predetermined distance from the top surface; placing an insert in the opening that rests on the plate flange of the tile bracket, the insert having a thickness that corresponds to the predetermined distance so that a top surface of the insert is flush with the top surface of the floor tile when the insert is disposed in the opening, the insert being transmissive to radio frequency waves; securing an antenna in the bracket so that the antenna is disposed directly under the insert when the insert is disposed in the opening; connecting a router to the antenna that generates network signals and receives network signals that are transmitted and received by the antenna as radio frequency waves through the insert.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top isometric exploded view of portions of an embodiment of a sensor floor tile.

FIG. **2** is a bottom isometric exploded view of portions of an embodiment of a sensor floor tile.

FIG. **3** is a bottom view of portions of an embodiment of a sensor floor tile.

FIG. **4** is a side cutaway view of an embodiment of a raised floor system.

FIG. **5** is an isometric view illustrating an implementation of sensor floor tiles laid out on a raised floor system that communicate with a wireless data manager.

FIG. **6** is a schematic illustration of an architectural structure of one embodiment of a data collection system using sensor floor tiles.

FIG. **7** is a schematic isometric top exploded view of another embodiment of the invention.

FIG. **8** is a schematic isometric bottom view of the embodiment of FIG. **7**.

FIG. **9** is a schematic bottom view of the embodiment of FIG. **7**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

FIG. **1** is a top isometric, exploded view of an embodiment of portions of a sensor floor tile **100**. As illustrated in FIG. **1**, floor tile **102** has an opening **104** that extends through the entire thickness of the floor tile **102**. A cylindrical tile bracket **108** extends up through the opening **104** and a low loss disk **106** fits within the opening **104** and rests on the plate flange **116** of the cylindrical tile bracket **108**. Various materials can be used for the low loss disk **106** that provide low losses to the transmission radio frequency (rf) energy. For example, many plastics provide low loss to the transmission of rf energy and simultaneously provide the strength and durability needed for the opening **104** in the floor tile **102**. One example is calcium carbonate which is a high strength plastic with low loss characteristics. Other materials can also be used such as glass, tempered glass, fiberglass, wood, wood and plastic mixtures, concrete or any other nonconductive material which is capable of transmitting radio frequency signals. In that regard, transmission of ir signals could also be used using a disk **106** that is transmissive to ir signals. The cylindrical tile bracket **108** has a bracket flange **118** that fits on the underside of the floor tile **102** and has holes to secure the cylindrical tile bracket **108** by bolts **110** through the bracket flange **118**. As shown in FIG. **1**, floor tile **102** is a standard floor tile that is solid and can be retrofitted with the cylindrical tile bracket **108** and low loss disk **106** by forming the opening **104** in the floor tile **102**.

FIG. **2** is an isometric, bottom exploded view of the sensor floor tile **100**. As illustrated in FIG. **2**, the floor tile **102** has the opening **104** that extends through the entire thickness of the floor tile **102**. The cylindrical tile bracket **108** has a cylinder portion **109** that fits within the opening **104**. The cylinder **109** then extends downwardly past the bracket flange **118**. The bracket flange **118** is mounted between the top and bottom of the cylinder **109**. In this manner, the cylinder **109** extends partway through the opening **104** in the floor tile **102**. The top portion of the cylinder **109** includes a ring which is a plate flange **116**. The plate flange **116** provides a cylindrical flat surface on which the low loss disk **106** rests. The distance in which the cylinder **109** extends through the opening **104** and the thickness of the plate flange **116** allow the low loss disk **106** to be inserted in the opening **104** and to be flush with the top surface of the floor tile **102**. Bolts **110** extend through openings in the bracket flange **118** and are secured to the bottom surface of the floor tile **102** to hold the cylindrical tile bracket **108** securely to the floor tile **102**. Bracket stud **123** and a similar bracket stud **125** (FIG. **3**) hold mounting bracket **114** (FIG. **3**).

FIG. **3** is a bottom view of the sensor floor tile **100** illustrating various sensors mounted in the sensor floor tile **100**. As illustrated in FIG. **3**, the cylindrical tile bracket **108** is mounted on the bottom surface of the floor tile **102**. A mounting bracket **114** is mounted to the bottom surface of the plate flange **116** using bracket studs **123**, **125**. The mounting bracket **114** holds the sensor/transmitter/antenna **112** in position against the bottom surface of the low loss disk **106**. The sensor/transmitter/antenna **112** may embody a number of different devices. In one implementation, the sensor/transmitter/antenna **112** may simply be an antenna that is capable of transmitting rf signals generated by a sensor. As disclosed below, the rf signals are detected by a receiver in the room which may detect a number of different signals from various floor tiles such as floor tile **102**. In another implementation, a sensor may be connected to the sensor/transmitter/antenna **112** and the sensor/transmitter/antenna **112** may comprise a transmitter and antenna that detects the sensor signal, amplifies the sensor signal and transmits the sensor signal through an embedded antenna. In another implementation, the sensor/transmitter/antenna **112** may include integrated sensors that detect various conditions and environmental factors surrounding the floor tile **102**. Various types of sensors that may be included internally within the sensor/transmitter/antenna **112**. For example, integrated sensors may include temperature sensors that sense the temperature of the surrounding area. Another example of an internal sensor in the sensor/transmitter/antenna **112** would be a temperature and humidity sensor that detects both the temperature and the humidity surrounding the sensor/transmitter/antenna **112**. In addition, differential air pressure can be detected by including a sensor that is connected to both the plenum and the above floor pressure so that a differential air pressure signal can be generated and transmitted through the sensor/transmitter/antenna **112**.

Various types of external sensors can also be connected to the sensor/transmitter/antenna **112** illustrated in FIG. **3**. As shown in FIG. **3**, pressure sensors **115**, **117**, **119**, **121** and located in the corner positions of floor tile **102**. The pressure sensors **115**, **117**, **119**, **121** generate a signal that is applied to the sensor/transmitter/antenna **112** when pressure is sensed on a corner of the floor tile **102**. In this manner, the antenna can generate a signal indicating that pressure has been detected on a particular corner of the floor tile **102**, so that movement over the floor tile **102** can be detected. The pressure sensors **115-121** can be piezo-electric sensors or other types of pressure or force sensors. The pressure sensors **115-121**, illustrated in FIG. **3**, operate in response to pressure on the floor tile, such as a person walking on a floor tile. Since these may constitute piezoelectric sensors, the pressure sensors **115-121** may require little or no power to generate an electrical signal. In this manner, it is easy to detect unauthorized access to portions of a computer room by simply tracking the movement indicated by the pressure sensors.

Other types of external sensors can also be connected to the sensor/transmitter/antenna **112** shown in FIG. **3**, which may function simply as a transmitter and antenna, or simply an antenna. For example, leak detectors may be connected to the sensor/transmitter/antenna **112** which detect leaks in the plenum **128** (FIG. **4**), as disclosed in more detail below. Other types of external sensors may include thermistors which are capable of accurately sensing the temperature in the plenum. Resistance temperature devices (rtds) can also be used to accurately determine temperatures that exist within the plenum below the floor tile **102**. In addition, air flow transducers can be connected to the sensor/transmitter/antenna **112** which detect the flow of air in the plenum at different locations. This information can be important in tracking the cooling or flow of air in the plenum, which is necessary to cool computer equipment that may be located above the floor tile **102**.

In one embodiment of the invention a plastic disk is used for the low loss disk **106** which is one half inch thick and has a diameter of 6 inches. Although various plastic materials can be used for the plastic disks, polycarbonate is a good material because of its high tensile strength, high durability and low deflection under force. Polycarbonates can be made clear so that the mounting of the antenna **112** and the condition in the plenum can be viewed from the top of the tile. The low loss disk **106** can be made from any material that has a low dielectric constant. For example, the low loss disk **106** can be made of any desired type of plastic, glass, fiberglass, wood, concrete or other low dielectric material as set forth above. In addition, the low loss disk **106** need not be clear, but can be opaque or partially optically transmissive. Since the low loss disk **106** is round and sits on a circular plate flange **116**, support is provided around the entire periphery of the low loss **106**. A low loss disk **106** having a diameter of 6 inches and a thickness of one half inch can withstand forces of over 1500 pounds per square inch. As such, heavy objects can be moved over the low loss disk **106** without fear of breakage. Also, the circular shape of the low loss disk **106** prevents the low loss disk **106** from falling through the opening **104**. Although the low loss **106** is shown as being circular and the cylindrical tile bracket **108** is also shown as being circular, any desired shape can be used. In that regard, the cylindrical tile bracket **108** may be an oval tile bracket, a square tile bracket, a rectangular tile bracket, etc. Similarly, the low loss disk **106** may have different shapes according to the shape of the tile bracket. As such, the low loss disk **106** may be a plastic insert that has a shape that fits the opening **104**. The cylindrical tile bracket **108** is simply a tile bracket that also has the shape that matches the opening **104**.

As illustrated in FIG. **4**, a typical raised floor system may include a number of floor tiles **127**, **102**, **122**, that are supported by floor tile stands such as floor tile stand **130** and floor tile stand **132**. The space between the floor tiles **127**, **102** and **122** and a sub-floor **129** is the plenum **128**. As discussed above, utilities such as plumbing, electrical utilities, and data cables can be run through the plenum **128**. Pipes **137** can be run through the plenum **128**, as well as electrical cables **135** and a network/data cable **133**. Occasionally, it is necessary to access these utilities because of leaks or additional connections that need to be made to the electrical cables **135** or network/data cable **133**. The floor tiles can be easily removed to access the pipes **137**, electrical cables **135** or network/data cable **133**. In addition, air conditioning and heating, in the form of forced air, can also be run through the plenum **128**. The use of floor tiles allows quick and easy access to the plenum **128** to correct any problems with the utilities or make changes to the utility system.

FIG. **4** also illustrates a cutaway view of the cylindrical tile bracket **108**, and the manner in which the cylindrical tile bracket **108** is mounted to the sensor floor tile **102**. The cylindrical tile bracket **108** is placed through the bottom of the sensor floor tile **102** into the opening **104** in the sensor floor tile **102**. Bracket flange **118** has openings that allow bolts **110** to connect the cylindrical tile bracket **108** to the bottom of the sensor floor tile **102**. The cylindrical tile bracket **108** is mounted in the opening **104** so that the plate flange **116** provides a round surface on which the low loss disk **106** is placed. The height of the top surface of the plate flange **116** allows the low loss disk **106** to sit within the opening **104** and be flush with the top surface of the sensor floor tile **102**. Sensor/transmitter/antenna **112** is mounted with a mounting bracket **114** that is connected to the bottom surface of the plate flange **116** by bracket studs **123**, **125** so that the top of the antenna portion of the sensor/transmitter/antenna **112** is pushed against the bottom surface of the low loss disk **106**. The low loss disk **106** is selected from a material that has high transmissivity of radio frequency waves, which are transmitted by the antenna portion of sensor/transmitter/antenna **112**. The sensor/transmitter/antenna **112** is connected to transducer **126**, in one embodiment, via cable **124**. The transducer **126** generates a data signal that is representative of the particular property that is being sensed by the sensor **112**. The transducer **126** may generate a digital or analog electrical signal that is representative of certain conditions that exist at the location of transducer **126**. The sensor/transmitter/antenna **112** transmits an RF signal through the low loss **106**. Wi-Fi router **135** is connected by cable **137** to network cable **133**. Wi-fi router **135** is connected to the sensor/transmitter/antenna **112** by way of cable **125**. The Wi-fi router **135** is capable of transmitting and receiving Wi-fi signals so that the Wi-fi signals can be transmitted by the sensor/transmitter/antenna **112** and received by the sensor/transmitter/antenna **112** through the low loss disk **106**. In this manner, Wi-fi services can be provided by the sensor floor tile **102** as disclosed in more detail below.

Transducer **126**, illustrated in FIG. **4**, can sense various properties. For example, transducer **126** can sense temperature, humidity, air flow, differential pressure, barometric pressure, physical force and other parameters. For differential pressure measurements, a hole can be formed through the low loss disk **106** and a plastic tube from a differential pressure sensor **112** can be mounted in the sensor floor tile **102** to detect pressure above the sensor floor tile **102**, through a hole drilled in the low loss disk **106**. Another tube can be attached to the differential pressure sensor **112**, which measures air pressure at any desired location in the plenum **128**. In this manner, differential pressure can be detected between the space above the sensor floor tile **102** and the desired location in the plenum **128**.

The sensor/transmitter/antenna **112**, in one embodiment, transmits radio frequency signals at about 900 megahertz. In other embodiments, sensor/transmitter/antenna **112** transmits radio frequency signals at 2.4 gigahertz. Batteries located in the sensor/transmitter/antenna **112** have a guaranteed lifetime of up to twelve years. This is possible since the sensors sense a particular condition on a periodic basis and not continuously. For example, sensor/transmitter/antenna **112** may sample each minute, each several minutes or each hour. Other sensors may only need to sense once or twice a day. The sensing operation and generation of a sensing signal on a periodic basis consumes very little power. Consequently, there is no need to connect the sensor/transmitter/antenna **112** or transducer **126** to a power source. Further, it is simple and easy to lift the sensor floor tile **102** and replace the battery pack and the sensor/transmitter/antenna **112** once every twelve years.

Although the transducer **126**, illustrated in FIG. **4**, is illustrated as a spot sensor, various other sensors can be utilized. For example, cable leak detectors can be laid out on the sub-floor **129** in a matrix. Leak detection cables and electronics can be employed that detect the specific location of a leak along the length of the leak detection cable so that a specific location can be provided for a leak. This is disclosed in more detail in U.S. Pat. Nos. 7,212,009, 7,081,759, 6,144,209, 8,601,679, 9,755,389, 8,063,309, 8,234,910 and 8,256,269, which are specifically incorporated herein, by reference, for all that they disclose and teach.

The sensor floor tile **102**, as illustrated in FIG. **4**, can be a retrofit floor tile, such as by retrofitting an existing floor tile, such as floor tile **122**. In that regard, the cost of installing a sensor floor tile **102** can be reduced by retrofitting a regular floor tile **122**. This can be easily done by simply drilling a six-inch round hole in the floor tile **122** and mounting the cylindrical tile bracket **108** in the six-inch opening.

FIG. **5** is a schematic isometric view of a raised floor tile system. The raised floor tile system, using sensor tiles, communicates with a wireless data manager **150**, or to a Wi-fi access point **151**, which in turn, is connected to a router. As illustrated in FIG. **5**, a room such as a computer room, data center, clean room, office space, etc., has a plurality of raised floor tiles **134**. Of those raised floor tiles **134**, a number of the floor tiles are sensor floor tiles that may sense various conditions. In a very large area such as a data center, a number of sensor floor tiles, such as sensor floor tile **136**, sensor floor tile **138**, sensor floor tile **140**, sensor floor tile **142** and sensor floor tile **144**, may be used to detect humidity, temperature, pressure, water leaks, differential pressure, airflow and other conditions at various locations. As also illustrated in FIG. **5**, the radio frequency wireless data signals **146** are transmitted through the plastic disks in the sensor floor tiles **136-144** and are received by antenna

148 or Wi-fi access point 151. Antenna 148 can be mounted in a raised location on a wall or on a ceiling or in a drop ceiling in the room. A wireless data manager 150 receives the data transmitted by the wireless data signals 146 and detects that data. The wireless data manager 150 may be connected to a wired network in the building or may transmit the processed data signals via antenna 148, or a separate antenna (not shown), to a network or other device.

The sensor floor tiles illustrated in FIG. 5 can also function as Wi-Fi transmitters, as set forth above, with respect to Wi-fi router 135 of FIG. 4. For example, the sensor floor tiles can be distributed throughout a building or large room, such as those that exist in data centers, to provide an antenna to transmit Wi-Fi signals to users located within the room or building. Wi-Fi service can be provided by Wi-Fi router 135 (FIG. 4) in the plenum 128 of FIG. 4. The Wi-Fi router 135 can be connected to an antenna mounted to the floor tile 102 with the mounting bracket 114 so that an Internet connection can be provided to users via the antenna mounted underneath the low loss disk 106.

FIG. 6 is a schematic layout of an embodiment of an architecture for transmission of sensor signals to a monitoring system. As illustrated in FIG. 6, sensor floor tiles 152, 154, 156 as well as many other sensor floor tiles, transmit sensor signals to antenna 160 of a wireless data manager 158, such as illustrated in FIG. 5. Similarly, sensor floor tiles 164, 166, 168, as well as possibly many other sensor floor tiles, transmit sensor signals to antenna 172 of wireless data manager 170. Wireless data manager 158 transmits the processed sensor data from sensor floor tiles 152, 154, 156 to range extender 162. Similarly, wireless data manager 170 transmits sensor data from sensor floor tiles 164, 166, 168 to range extender 162. Range extender 162 then transmits all of the sensor signals to a data center manager 174. The data center manager 174 may then be connected to either a local network or the Internet to transmit information to a remote location, if necessary. Many data centers, as well as large buildings, have proprietary monitoring systems, which utilize the data provided to the data center manager 174.

Similarly, sensor floor tiles 176, 178, 180 transmit sensor signals to antenna 184 of the wireless data manger 182 that processes the wireless data signals. Sensors 190, 192, 194 transmit the wireless sensor data to antenna 198 of wireless data manager 196, which processes the sensor data. Both wireless data manager 182 and wireless data manager 196 transmit the data to antenna 188 of range extender 186. Range extender 186 transmits the data to the data center manager 174. Of course, the data center 174 can directly receive the data from the wireless data managers if the data center manager 174 is located sufficiently close to the wireless data managers. As indicated above, the data center manager 174 can be connected to a local network or the Internet through either a hardwired network connection or a wireless connection. Various monitoring and security systems can be used, and many buildings, data centers, computer rooms, etc., have proprietary monitoring systems. One exemplary monitoring system is the Falcon system that is disclosed in U.S. Pat. No. 9,420,042, which is specifically incorporated herein by reference, for all that it discloses and teaches. In that regard, Network Management Systems (NMS) and Building Management Systems (BMS) are utilized by various monitoring and security companies. Network Operation Centers (NOCs) can display status signals, including alarm signals for monitoring systems that allow monitoring personnel to view and manage the infrastructure of data centers, clean rooms, computer rooms and office spaces.

FIG. 7 is a schematic isometric top view of another embodiment of the sensor floor tile 200 of the present invention. As illustrated in FIG. 7, the floor tile 202 has an opening 204. Low loss disk 206 is the size and shape to fit within the opening 204. Although a round low loss disk 206 and a round opening 204 shown, any desired shape can be used. The low loss disk 206 has a cylindrical portion 208 that has a depth that matches the depth of the floor tile 202. Flange plate 212 is secured to the bottom portion of the floor tile 202 with flange bracket 214, flange bracket 216 (FIG. 8) and bolts 210. The flange plate 212 provides a surface on which the bottom of the cylinder 208 of the low loss disk 206 rests so that the top surface of the low loss disk 206 is flush with the top surface of the floor tile 202. Mounting bracket 220 holds the sensor/transmitter/antenna 218 against the interior portion of the cylinder 208 of the low loss disk 206.

FIG. 8 is a schematic bottom exploded view of the sensor floor tile 200. As illustrated in FIG. 8, the low loss disk 206 includes a cylinder 208 that extends downwardly from the top surface of the low loss disk 206. Cylinder 208 leaves an open area on the inside portion of the cylinder 208 in which the sensor/transmitter/antenna 218 is placed. The depth of the cylinder 208 extends through the thickness of the floor tile 202 to rest on the flange plate 212 so that the top surface of the low loss disk 206 is flush with the top surface of the floor tile 202. Flange brackets 214, 216 are engaged by bolts 210 which extend through the flange brackets 214, 216, the flange plate 212 and into threaded openings in the bottom surface of the floor tile 202. In this manner, the flange plate 212 is held in place at the opening 204 and provides a plate surface on which the bottom of the cylinder 208 rests. Sensor/transmitter/antenna 218 fits into the mounting bracket 212 which holds the sensor/transmitter/antenna 218 in the internal portion of the cylinder 208. Mounting bracket 220 is held in place by two of the bolts 210.

FIG. 9 is a schematic bottom view of the sensor floor tile 200 in an assembled construction. As illustrated in FIG. 9, the bottom surface of the system is illustrated. Flange brackets 214, 216 hold the flange plate 212 on the bottom surface of the floor tile 202. Mounting bracket 220 holds the sensor/transmitter/antenna 218 inside of the cylinder portion 208 of the low loss disk 206.

Consequently, the present invention provides for the wireless transmission of various sensor data using sensor floor tiles that utilize an RF frequency transmissive plate that transmits sensor signals to a wireless data manager. In addition, Wi-Fi signals can be transmitted through the low loss disks in the floor tiles to allow network connection to provide distributed Internet connections in which the sensor floor tiles are utilized.

The foregoing description of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and other modifications and variations may be possible in light of the above teachings. The embodiment was chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and various modifications as are suited to the particular use contemplated. It is intended that the appended claims be construed to include other alternative embodiments of the invention except insofar as limited by the prior art.

What is claimed is:

1. A sensor floor tile comprising:

a metal floor tile having an opening that extends from a top surface to a bottom surface of said floor tile;

a tile bracket connected to said floor tile, said tile bracket having a plate flange that is disposed a predetermined distance below said top surface of said floor tile;

an insert disposed in said opening and placed against said plate flange, said insert having a thickness that corresponds to said predetermined distance so that said insert is flush with said top surface of said floor tile, said insert composed of a material having high transmissivity of radio frequency signals;

a mounting bracket connected to said tile bracket;

a wireless communicator assembly disposed in said mounting bracket so that said wireless communicator assembly is adjacent to said insert;

wherein wireless signals are transmitted by said wireless communicator assembly as radio frequency waves through said insert.

2. The sensor floor tile of claim **1** wherein said wireless communicator assembly has an internal sensor that generates sensor signals, an internal radio frequency transmitter that generates radio frequency signals in response to said sensor signals; and an internal antenna that transmits said radio frequency signals.

3. The sensor floor tile of claim **1** wherein said wireless communicator assembly comprises a transmitter that receives sensor signals from a sensor, said transmitter not being adjacent to said insert, said transmitter generating radio frequency signals that are transmitted by an antenna disposed adjacent to said insert.

4. The sensor floor tile of claim **1** wherein said wireless communicator assembly comprises an antenna that transmits radio frequency signals that is disposed adjacent to said insert and a sensor and a transmitter that are not disposed adjacent to said insert.

5. A method of transmitting sensor data in a raised floor system comprising:

providing a metal floor tile with a top surface and a bottom surface and an opening that extends through a thickness of said floor tile between said top surface and said bottom surface;

connecting a tile bracket to said floor tile, said tile bracket having a plate flange;

mounting said plate flange to said floor tile such that said plate flange extends into said opening so that said plate flange plate is located at a predetermined distance below said top surface of said floor tile;

disposing an insert in said opening such that said insert rests on said plate flange, said insert having a thickness that corresponds to said predetermined distance so that a top surface of said insert is flush with said top surface of said floor tile, said insert composed of a material having high transmissivity of radio frequency signals;

connecting a mounting bracket to said tile bracket, said mounting bracket having a wireless communicator assembly secured thereto that is located adjacent to or directly under said insert; and

transmitting sensor signals by radio frequency waves from said wireless communicator assembly through said insert.

6. The method of claim **5** wherein said wireless communicator assembly further comprises a sensor, a transmitter and an antenna directly under said insert.

7. The method of claim **5** wherein said wireless communicator assembly further comprises a transmitter and an antenna directly under said insert, but not a sensor.

8. The method of claim **5** wherein said wireless communicator assembly further comprises an antenna directly under said insert, but not a sensor or a transmitter.

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